NASA's Navigator Program

NASA's program to find and study Earth-like Planets and other Solar systems

Philippe Crane
ORIGINS Theme Scientist, NASA HQ

January 9, 2002

Navigator Program's Current Elements

- The Terrestial Planet Finder(TPF) Mission is the flagship mission toward which the other elements of the Planet Finding effort focus.
  - TPF's specific goal is to directly detect Earth-like planets and to study the properties in sufficient detail to determine if they could biological systems.
  - TPF's broader goals are to determine
    - how stable planetary systems form and evolve
    - how biological systems develop and evolve
- TPF addresses the two guiding questions of the Origins Theme
  - How did we get here?
  - Are we alone?
- TPF is an extra-ordinarily ambitious program which requires careful preparation from both the technical and scientific side.
  - Navigator program office at JPL is guiding these efforts.
  - Navigator program includes
    - Ground-based observations
    - Flight Missions
    - TPF Preparatory Science
    - Michelson Fellowships

NAVIGATOR PROGRAM ELEMENTS

- Ground-based efforts:
  - Origins of Solar Systems Program with the R&A program(Managed at NASA HQ)
    - Searches for planets
    - Theoretical studies of planet formation and evolution.
  - KECK Interferometer (Fully operational in 2004)
    - Determine the exo-zodiacal dust content of TPF targets
    - Astrometric searches for long period planets
  - LBT Interferometer (NASA has 20 nights/year starting in 2006)
    - Determine exo-zodiacal dust
- Flight Missions
  - Space Interferometry Mission(SIM). (Launch 2009)
    - Puts the “T” in TPF
    - First Space Interferometer
    - Detection of earth-like planets and determination of their masses
  - Star-light (Launch in 2006)
    - Formation flying
    - Separated space-craft interferometry
  - Kepler (recently selected in the Discovery Program)
    - Determine the frequency of Earth-like planets.

All Roads Lead to TPF *and Beyond*

CANDIDATE TPF ARCHITECTURES

HYPER-TELESCOPE

VISIBLE CORONAGRAPH

SEPARATED S/C IR INTERFEROMETER

IR INTERFEROMETER ON A BOOM

IR CORONAGRAPH

Key Technologies

Visible Coronagraph	Separated S/C IR Interferometer	IR Interferometer on a Boom / IR Coronagraph
Large Lightweight Visible Optics Precision Deployable Structures High Contrast Imaging ($<10^{-9}$) Wavefront Sensing & Control	Precision Formation Flying Achromatic Nulling ($<10^{-6}$) Cryogenic Opto-Mechnaics Low Vibration Cryo-cooler	Precision Deployable Structures Achromatic Nulling ($<10^{-6}$) Cryogenic Opto-Mechnaics Low Vibration Cryo-cooler

Flight Precursors

ECLIPSE, NGST	StarLight	SIRTF, SIM, NGST

SIRTF, SIM, NGST

KEPLER → TPF ← TPF-*Lite*

Open Solicitations and Future Solicitations

- Extra-Solar Planets Advanced Mission Concepts NRA
  - 3 types of proposals solicited
    - Type 1: SIM science alternative
    - Type 2: TPF technology or science precursor
    - Type 3: TPF technology not requiring flight opportunity
  - All proposals were for 6 month studies of potential missions with an option for a further 6 months and with no guarantee of a mission actually flying
  - Proposal received and reviewed
  - Selections are imminent (before the end of January)
- TPF Precursor Science NRA
  - Understand the most troublesome issues through observations of the most planet-like objects we can get our hands on!
  - Primarily ground-based observational or theoretical efforts required for the success of TPF
  - Concept still being developed (more later)

TPF Status and Plans

- 4 Industry/University Architecture studies have just finished
  - Final Architecture Review of 4 Industry/University groups held 11-13 Dec 2001. Reports due in Mar/Apr 02
  - Selection of 2 architectures for further development in May/Jun 02
- Technology and Science Roadmaps toward TPF are being developed.
  - Advanced Mission Concepts NRA results are expected to support TPF technology
  - TPF Precursor Science NRA in formulation for release in mid 2002
  - Further Technology developments will be commissioned both at JPL and competed in the community
    - Cyro-cooler developments
    - High contrast imaging
    - Light weight optics

TPF Preparatory Science Program Goals

- To help define the appropriate architecture for TFP
  - Visible Coronographs vs. Nulling IR interferometers.
  - Wavelengths optimization
  - Other??
- To develop top-level science requirements for TPF
  - Sensitivity and background requirements;
  - spectral and spatial resolution, etc.
- To support broadly extra-solar planet research
  - Understand how planetary systems form and evolve
  - Understand which systems will form stable configurations
  - Ensure that the TPF we build will provide critical confirmation of our theories of the origin and evolution of planetary systems, and
  - Detect Earth-like planets that could support biological systems.
- Comments please !
  - We welcome comments on all aspects of how to structure the TPF Preparatory Science Program

What does the proposed NRA cover ?

- NRA for TPF Preparatory Science being prepared
  - Scientific Roadmap for the Terrestrial Planet Finder mission
  - A mix of large and small programs will be supported:
    - *Type 1:* small or short-duration programs
      - Similar to current "Origins of Solar Systems" R&A program.
      - Example: Critical studies of potential TPF targets.
    - *Type 2:* 'Pilot' proposals for large or long-term programs of up to around $ 500 k / year
      - Examples: pilot observing runs with a new instrument
      - and/or 'Phase A' paper study of the feasibility, cost, and implementation for a big survey
  - Funding:
    - First awards in fall 2002, continuing to at least 2006
    - Expect to fund several awards starting with total funding of $ 1M /year and possibly ramping up to $ 3M /year

Scope and Guidelines

- Scope of research covered by this NRA
  - Ground-based observational programs
  - Theoretical studies
  - Numerical modeling
- Guidelines for proposers
  - Results of program must be ready by 2006
    - Support TPF architecture downselect
  - Observing programs should use existing facilities
    - Should make effective use of existing small telescopes if possible: large observing blocks, automated operation, long duration
    - Requests for new/upgraded instrumentation will be considered
  - Results from program will be archived for community access
    - Proposers must provide an analysis and archive plan
  - Excluded from this NRA: telescopes already supported by NASA to do related work: e.g. Keck Interferometer, LBTI